-Update-
Experimental Flow Options
for the
Technical Work Group

Grand Canyon Monitoring and Research Center
January 20, 2006

Introduction:
Agreement on an experimental flow regime or operation of Glen Canyon Dam (GCD) is a fundamental element of the FY 07-FY 11 Monitoring and Research Plan (MRP). Following is a preliminary description and evaluation of three experimental flow options for consideration by the Science Planning Group. Option 1 and 2 were developed primarily by GCMRC; Option 3 reflects a proposal presented by WAPA, ADFG, and FFF at the November 2005 TWG meeting (as amended); Option 4 reflects a proposal by the Grand Canyon Trust to implement a modified version of a 2000 proposal by Rich Valdez et al which provides for extended periods of steady flows.

These options are provided to facilitate a productive evaluation of alternative GCD operations by the SPG (and TWG). The options are not meant to be exhaustive and SPG may ultimately develop and evaluate additional options beyond those presented below e.g., combine the best elements of different options or consider an entirely new option.

It is anticipated that each of the experimental flow regimes would be implemented in conjunction with some or all of the following "non flow" treatments or actions:

- Implementation of a selective withdrawal structure on Glen Canyon Dam (GCD) to enhance water temperature and other water quality parameters in the Colorado River below GCD
- Implementation of the some or all elements of HBC Comprehensive Plan (refugia, translocation, etc)
- Implementation of mechanical removal of non native fishes that compete with or prey upon native fishes

The SPG reviewed and discussed these options at its January 9-10, 2006 meeting. The SPG agreed on a process and schedule to better define the scope, objectives and timing of these experimental options (Attachment 1). The SPG also agreed to select the preferred option at its meeting on Feb 22-23, 2006.

Option 1 – Continue Baseline Monitoring of Modified Low-Fluctuating Flow Operation Under the 1996 Record of Decision w/Testing of Beach Habitat Building Flows (BHBF) and winter ramping rate studies

1) Flow Regime– the daily operation of Glen Canyon Dam is continued under the operating rules defined in the Record-of-Decision during all months as determined by projected annual hydrology. Stable flows would not occur within any month of the water year, except for the purpose of flying remote sensing missions before and following BHBF tests.

- Daily ranges in flow are 4,000, 5,000 or 8,000, while the hourly ramping rates are 4,000 cfs/hr up and 1,500 cfs/hr down.
- Flows below 8,000 cfs are only allowed between 1900 and 0700 each day.
- Down-ramping rate studies would occur in the months of December through March, whereby a range of changes in down-ramping rates would be evaluated with respect to sandbar habitat stability.
- BHBF tests would be conducted to determine the most effective operation for conserving sediment and creating and maintaining sandbars and associated backwater habitats. BHBF tests would occur following tributary sand enrichment and some period of MLFF operations to distribute sand throughout critical downstream reaches. The duration of BHBF would be 2-days or perhaps even shorter.
- Studies would be conducted to determine whether or not implementation of the BHBF and alternative winter or spring diurnal fluctuations affect (a) the formation, and persistence of sandbars (b) the abundance and distribution of near-shore backwater habitats, and (b) the use of the use of backwaters by humpback chub during subsequent summer and fall months.

2) Pros –
   - Provides continuity with baseline data on similar operations that have occurred consistently in spring, summer and fall months since 1991, with respect to fisheries and sand conservation studies, while major treatments (river warming and mechanical removal) are implemented (both started in WY 2003 and continue at present).
   - Will determine whether and under what conditions BHBF's can be more effectively used to achieve desired restoration and maintenance of sandbars and related habitats.
   - Assesses humpback chub recruitment under MLFF, a prolonged period of exotic fish control, and naturally occurring warmer river temperatures; (warming that approximates what might occur under future operation of a Selective Withdrawal Structure).
   - Defers the high costs associated with stable flow tests with the expectation that benefits to native fishes and other resources can be achieved without such costly or controversial treatments being implemented.

3) Cons –
   - If non-steady habitat conditions are the key factor limiting chub recruitment, then this option will delay the desired biological benefits to endangered fish and delayed learning about that fact. (The importance of habitat stability vs. influence of warmer water in chub recruitment was clearly identified as a fundamental uncertainty in the recent Knowledge Assessment workshops).
   - Reduced power generation that meets customer demands (as compared to Option 3).

Option 2 – "Baseline Monitoring of Modified Low-Fluctuating Flow Operation Under 1996 Record of Decision w/BHBF Testing + Winter ramping rate studies + Stable Flow Operations in September & October"

1) Flow Regime . The same as Option 1 except that stable flows would be implemented and tested in September and October. The level of stable flow depends on annual hydrology and may vary through the course of the experimental period, 2007-2011.

2) Pros –
   - Same as Option 1
   - Stable flows in the fall may result in stable habitat conditions that enhance recruitment of YOY native fishes (HBC)

3) Cons –
   - Reduced power production to meet customer demands and the higher power replacement costs
   - Experimental results are potentially confounded by having three major flow and non-flow treatments implemented simultaneously. If the desired fisheries response does occur under this suite of treatments, it is not possible to determine which of the three treatments provides the most or least significant role in the response. Learning is limited compared with Option 1.

Option 3 – WAPA/AFGD/FFF "Experimental Modification of the Record-of-Decision Modified Low-Fluctuation Flow"

1) Flow Regime The daily operation of Glen Canyon Dam is under a hybrid of fluctuating operations that closely approximates MLFF
   - Down ramp rates are increase for seven months, increased daily range [10,000 to 12,000 cfs] increased down ramp rate [3,000 cfs/hr]) for five months.
   - Up ramp appears to be identical ROD in all twelve months.
   - In five of the twelve months, the daily minimum flow is lower by approximately 5,000 cfs in winter [December through February] and 3,000 cfs in summer [July & August].
   - In every month, this option includes one to three additional "on-peak" hours, but the peaks appear to be essentially identical to those that would occur under the strict MLFF, as described in Option 1.
   - It is unclear from the current proposal whether BHBF tests would be conducted under this option and if so under what terms and conditions.
   - Its unclear whether this option includes studies to determine the affects of the proposed operation on (a) the formation, and persistence of sandbars (b) the abundance and distribution of near-shore backwater habitats, and (b) the use of the use of backwaters by humpback chub during subsequent summer and fall months.
2) Pros –
   - Increased generation of hydropower during winter and summer months by the better aligning dam operations with daily customer power demands.

- Presumed increase aquatic food and drift which may benefit both the trout fishery and native fish.
- Increased summer flows would inhibit successful trout reproduction which may benefit native fishes
- Although not identical to MLFF operations, there is still an emphasis on continuity with limited fluctuating-flow baseline data for similar operations that have occurred consistently in spring, summer and fall months since 1991, with respect to fisheries and sand conservation studies.
- Biological response studies could continue to focus on the potential for successful humpback chub recruitment under MLFF, a prolonged period of exotic fish species control, and naturally occurring warmer river temperatures that approximate what might occur under operation of a Selective Withdrawal Structure.
- The high costs associated with stable flows are also still deferred for some time, with hope that the desired biological benefits to native can be achieved without such a costly or controversial treatment being implemented.

3) Cons
   - The fluctuating-flow operations are not identical to those for which 15 years of baseline data have been collected with respect to fisheries and sediment resource responses. This may be a concern especially for the summer months of July and August, where biological responses of fish and the food base are not well documented or highly predictable.
   - If non-steady habitat conditions are the key factor limiting chub recruitment, then this option will delay the hoped-for biological benefits to endangered fish and delayed learning about that fact. (The importance of habitat stability vs. influence of warmer water in chub recruitment was clearly identified as a fundamental uncertainty in the recent Knowledge Assessment workshops).
   - Potentially greater export of sand although this can not be fully analyzed without additional information

Option 4 – Grand Canyon Trust (GCT) Experimental Modification of the Record-of-Decision Modified Low-Fluctuation Flow

Flow Regime. The RPA and Valdez et al. report (Valdez et al. 2000) would serve as the foundation for designing the experimental flows. However, the Valdez et al. design may be modified after considering new information (e.g., LSSF results, research results since 2000 and the Knowledge Assessment). For example, it would be useful to evaluate whether the spike flows recommended in the Valdez design have enough value to the fish community to offset the potential negative impact they might have to trout, hydropower generation, sediment conservation or other park values. The Valdez et al. (2000) proposal consists of:

- 1 year of MLFF at 8.23 maf ($MLFF_{8.23}$), as a baseline, followed by 2 years of the EF hydrograph at 8.23 maf ($EF_{8.23}$), as independent treatments.

- The EF hydrograph for each treatment extends for 1 year and consists of a high steady release of 21,400 cubic feet per second (cfs) from mid-March through May with a 4-day spike of 33,000 cfs in late April.
- This is followed by a low steady release of 8,000 cfs from June through February with a 4-day spike of 33,000 cfs in late September.
- Ramping rates of 4,000 cfs/hr up and 1,500 cfs/hr down are applied to the two spike releases.
- Based on the pattern of dam releases from 1964 to 1998, the probability of a release of 8.5 maf, or less, is about 46%, and the probability of consecutive years of 8.5 maf, or less, is only about 26%. Hence, consecutive years of approximately 8.23 maf releases are unlikely to occur, and the study design considers each $EF_{8.23}$ as an independent treatment for comparison against the 1-year baseline of $MLFF_{8.23}$, supplemented with data from previous studies.
- If Glen Canyon Dam is modified to control downstream temperatures before the program of experimental flows is implemented, the temperature control device must be implemented equally during both the baseline and treatment years.
- Other experimental releases from Glen Canyon Dam (e.g., beach/habitat building flows, test floods) should not be implemented during the 3-year program of EF in order to avoid confounding results of the EF. However, if water volume is available, the 4-day spike can be allowed to exceed 33,000 cfs.

4) Pros –
   - The major results from implementing the experimental flows are to benefit humpback chub and other native fish, and satisfy Element 1A of the RPA.

5) Cons –
   - Reduced power production to meet customer demands and the higher power replacement power costs.

SPG Process and Schedule for Evaluating Experimental Options and Designs

1. GCMRC will further evaluate and describe similarities and differences in the proposed experimental options including a new option proposed by Rick Johnson for extended periods of steady flows (patterned after Valdez's 2000 proposal). Rick will provide a written description of his option to GCMRC. Rick's expectation is that GCMRC will modify and adjust the proposal based on new information. WAPA will provide written description of Opt 3. (GCMRC will send an outline to WAPA and Rick Johnson identifying info that should be included in the write-up). Impacts of options to all resource categories/AMP goals will be evaluated (including an analysis of impacts to habitat required to support extirpated species i.e., SWF, RBS, CP, NLF). Expand pros and cons of each option.
2. GCMRC's will utilize a format that facilitates easy comparison by the SPG
3. The evaluation will focus on next 5 years but will be put in context of a long term (e.g., 10 year) plan or perspective
4. The evaluation will identify the experimental hybrid design(s) (as defined by AMWG) associated with each option and the implications for "learning" and resource restoration
    - Management action – a management action is an action that is turned on and left on indefinitely and is not formally tested/evaluated (based on manager's review of the KA, other pertinent scientific info, and an assessment of the risk of being wrong). For the purposes of this exercise the person proposing the option will initially define the "management actions" associated with the option. This will be reviewed at the next SPG meeting with understanding that a more detailed assessment will occur in next planning cycle
    - Id strengths and weaknesses of each design in terms of timeframes (duration required for success), financial costs, degree of learning, resource risks, etc
5. The evaluation will include a hydrograph for each option. The hydrograph will show monthly volumes, and max and min flows for each month

6. GCMRC will complete its evaluation by Feb 13 for consideration by the SPG at it Feb 21 meeting **FOR A DECISION OR RECOMMENDATION TO TWG**